Compliments of exactEarth®

Special Edition

# Satellite AIS

FOR DUMMIES®

A Wiley Brand

**Learn to:**

- Grasp Satellite AIS technology
- Track global maritime traffic
- Understand the maritime domain like never before

Heather Ball

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

# Satellite AIS

FOR

# DUMMIES®

SPECIAL EDITION

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

# Satellite AIS

FOR

DUMMIES®

SPECIAL EDITION

**by Heather Ball**

WILEY

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

**Satellite AIS For Dummies®, Special Edition**

Published by
**John Wiley & Sons Canada, Ltd.**
6045 Freemont Blvd.
Mississauga, ON L5R 4J3
www.wiley.com

Copyright © 2013 by John Wiley & Sons Canada, Ltd.

All rights reserved. No part of this book, including interior design, and icons, may be reproduced or transmitted in any form, by any means (electronic, photocopying, recording, or otherwise) without the prior written permission of the publisher.

ISBN: 978-1-118-48494-4

Printed in the United States

1 2 3 4 5 DPI 17 16 15 14 13

For general information on John Wiley & Sons Canada, Ltd., including all books published by Wiley Publishing Inc., please call our distribution centre at 1-800-567-4797. For reseller information, including discounts and premium sales, please call our sales department at 416-646-7992. For press review copies, author interviews, or other publicity information, please contact our publicity department, Tel. 416-646-4582, Fax 416-236-4448.

For general information on our other products and services, or how to create a custom For Dummies book for your business or organization, please contact our Business Development Department at 877-409-4177, contact info@dummies.biz, or visit www.wiley.com/go/custompub. For information about licensing the For Dummies brand for products or services, contact BrandedRights&Licenses@Wiley.com.

**LIMIT OF LIABILITY/DISCLAIMER OF WARRANTY: THE PUBLISHER AND THE AUTHOR MAKE NO REPRESENTATIONS OR WARRANTIES WITH RESPECT TO THE ACCURACY OR COMPLETENESS OF THE CONTENTS OF THIS WORK AND SPECIFICALLY DISCLAIM ALL WARRANTIES, INCLUDING WITHOUT LIMITATION WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE. NO WARRANTY MAY BE CREATED OR EXTENDED BY SALES OR PROMOTIONAL MATERIALS. THE ADVICE AND STRATEGIES CONTAINED HEREIN MAY NOT BE SUITABLE FOR EVERY SITUATION. THIS WORK IS SOLD WITH THE UNDERSTANDING THAT THE PUBLISHER IS NOT ENGAGED IN RENDERING LEGAL, ACCOUNTING, OR OTHER PROFESSIONAL SERVICES. IF PROFESSIONAL ASSISTANCE IS REQUIRED, THE SERVICES OF A COMPETENT PROFESSIONAL PERSON SHOULD BE SOUGHT. NEITHER THE PUBLISHER NOR THE AUTHOR SHALL BE LIABLE FOR DAMAGES ARISING HEREFROM. THE FACT THAT AN ORGANIZATION OR WEBSITE IS REFERRED TO IN THIS WORK AS A CITATION AND/OR A POTENTIAL SOURCE OF FURTHER INFORMATION DOES NOT MEAN THAT THE AUTHOR OR THE PUBLISHER ENDORSES THE INFORMATION THE ORGANIZATION OR WEBSITE MAY PROVIDE OR RECOMMENDATIONS IT MAY MAKE. FURTHER, READERS SHOULD BE AWARE THAT INTERNET WEBSITES LISTED IN THIS WORK MAY HAVE CHANGED OR DISAPPEARED BETWEEN WHEN THIS WORK WAS WRITTEN AND WHEN IT IS READ.**

**Trademarks:** Wiley, the Wiley Publishing logo, For Dummies, the Dummies Man logo, A Reference for the Rest of Us!, The Dummies Way, Dummies Daily, The Fun and Easy Way, Dummies.com, Making Everything Easier, and related trade dress are trademarks or registered trademarks of John Wiley & Sons, Inc. and/or its affiliates in the United States and other countries, and may not be used without written permission. All other trademarks are the property of their respective owners. John Wiley & Sons, Inc., is not associated with any product or vendor mentioned in this book.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

## Publisher's Acknowledgments

We're proud of this book; please send us your comments at `http://dummies.custhelp.com`.

Some of the people who helped bring this book to market include the following:

***Acquisitions and Editorial***

**Acquiring Editor:** Anam Ahmed

**Manager, Custom Publications:** Christiane Cormier

**Production Editor:** Elizabeth McCurdy

**Copy Editor:** Andrea Douglas

***Composition Services***

**Project Coordinator:** Kristie Rees

**Layout:** Kathie Rickard

**Proofreader:** Dwight Ramsey

---

**John Wiley & Sons Canada, Ltd.**

**Deborah Barton,** Vice President and Director of Operations

**Jennifer Smith,** Publisher, Professional Development

**Alison Maclean,** Managing Editor

**Publishing and Editorial for Consumer Dummies**

**Kathleen Nebenhaus,** Vice President and Executive Publisher

**David Palmer,** Associate Publisher

**Kristin Ferguson-Wagstaffe,** Product Development Director

**Publishing for Technology Dummies**

**Andy Cummings**, Vice President and Publisher

**Composition Services**

**Debbie Stailey,** Director of Composition Services

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

# Table of Contents


**Introduction ..... 1**

About This Book ..... 1
Foolish Assumptions ..... 2
Icons Used in This Book ..... 2
Where to Go from Here ..... 3

**Part 1: Exploring the Automatic Identification System ..... 5**

AIS: Acronym Introduction Section ..... 5
Knowing What AIS Is For ..... 6
Discovering How AIS Works ..... 7
Broadcasting information ..... 7
Using time slots ..... 7
TDMA ..... 8
SOTDMA ..... 8
When slots collide . . . ..... 10
Looking at What an AIS Message Contains ..... 10
Checking Out Types of AIS Devices ..... 11
Class A ..... 11
Class B SO ..... 12
Class B CS ..... 13
AIS SART ..... 13
AIS aids to navigation ..... 14
AIS base stations ..... 14
Considering the Safety Benefits of AIS Technology ..... 15
Noting AIS Limits ..... 15
The 50-mile barrier ..... 16
Breaking the 50-mile barrier ..... 16

**Part 2: Satellite AIS: Alerts from Space! ..... 17**

S-AIS: Out of This World ..... 17
Getting the Big Picture with S-AIS ..... 19
Seeing the Two Types of S-AIS ..... 20
On-board processing ..... 20
Spectrum decollision processing ..... 21

**Part 3: The exactView System ..... 23**

Understanding exactEarth's Technology ..... 23
Microsatellites, Macro Benefits ..... 24
Small is smart ..... 24
Collecting the data ..... 25
Meeting exactEarth's Technology Team ..... 25


These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

**Part 4: The Versatility of S-AIS . . . . . .31**

Recognizing Uses for S-AIS . . . . . 31
Vessel Tracking . . . . . 32
Safer ship routing . . . . . 32
Enabling VTMIS (Vessel Traffic Monitoring and Information Systems) . . . . . 32
Ship reporting . . . . . 33
Remote region monitoring . . . . . 33
Validation of ship declarations . . . . . 34
Efficient vessel traffic services (VTS) . . . . . 34
Arrival management . . . . . 34
Effective vessel traffic analysis . . . . . 35
Search and Rescue . . . . . 35
Tracking and assisting distressed vessels . . . . . 35
Casualty alerting . . . . . 36
Natural disaster relief . . . . . 36
Security and Surveillance . . . . . 37
Piracy monitoring . . . . . 37
Smuggling prevention . . . . . 37
Mitigating infectious disease . . . . . 38
Increasing vessel safety in hostile waters . . . . . 38
Vessel identification with radar and digital imagery . . . 38
Monitoring aids to navigation operations . . . . . 39
Environmental . . . . . 39
Pollution control . . . . . 40
Environmental preservation . . . . . 40
Fisheries protection . . . . . 41

**Part 5: exactAIS in Action . . . . . .43**

Vessel Monitoring Case Study: Arctic Monitoring and Shipping . . . . . 43
Opening new routes . . . . . 44
On thick ice . . . . . 45
How S-AIS helps . . . . . 46
Search and Rescue Case Study: Casualty Alerting . . . . . 47
Safer shipping . . . . . 47
How S-AIS helps . . . . . 48
Security and Surveillance Case Study: Preventing Piracy . . . . . 49
How S-AIS helps . . . . . 50
Environmental Protection Case Study: Guarding Sensitive Areas . . . . . 51
Keep out of these areas . . . . . 52
How S-AIS helps . . . . . 52

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

# Introduction

Here's a fact that you just can't water down: About 70 percent of the world's surface is ocean. People rely on these oceans — big time — because 90 percent of today's global trade takes place on the ocean. Industry, governments, maritime authorities, and businesses need to have a comprehensive picture of what's going on at sea in order to protect people.

Technology exists to address this critical need to have a complete global maritime picture. The *Automatic Identification System* (AIS) is an established technology for tracking maritime activity, but it's not without its visibility limitations; it can see only so far from the coast. That's why *Satellite AIS* (S-AIS) is becoming more popular — the maritime community is *literally* seeing reliable vessel monitoring that goes far beyond what was once thought possible.

And with more advances in satellite constellations and ground stations, the amount and quality of data that can be collected from space is increasing. Thanks to these advancements, S-AIS not only gives a complete global view of the entire world's shipping but also is the only technology that tells the complete story of maritime activity. S-AIS enables the timely and accurate monitoring of ships across the globe.

## About This Book

This book is a reader-friendly guide to the basics behind AIS and S-AIS technology. Here's what you can expect from each of the book's five parts:

- **Part 1: Exploring the Automatic Identification System —** This part explains what AIS is, its uses, and how it works.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

- **Part 2: Satellite AIS: Alerts from Space! —** This part is where you can find out about the way satellite technology makes AIS an even more powerful tool for mariners, maritime authorities, governments, and businesses.
- **Part 3: The exactView System —** This part introduces you to exactEarth's Satellite AIS system, including the benefits of using satellites to monitor activities at sea.
- **Part 4: The Versatility of S-AIS —** This part surveys the broad spectrum of applications for S-AIS.
- **Part 5: exactAIS in Action** —This part provides real case studies to show you how maritime authorities around the globe are using exactAIS. (Plus, it's got pirates!)

# Foolish Assumptions

If you're reading this book, you're likely one of three kinds of readers:

- You have no idea what Satellite AIS is, but you're intrigued and ready to find out.
- You're familiar with AIS and want to discover how it works together with satellite technology.
- You know about the concept of Satellite AIS, but you're wondering how it applies to real-life situations.

# Icons Used in This Book

In the margins of this book, you'll notice a few special aids to navigation so that you can find the information you want with ease. Here's what they mean:

This icon signals a tidbit of interesting information.

When you see the Remember icon, stay the course, because you're about to read something important.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

Geeks ahoy! This icon points out information that is a bit more technical in nature. You can skip it if you'd prefer, but you'll likely find it fascinating.

# Where to Go from Here

One thing you don't need for this book is a set navigation plan, because you can start reading wherever you want.

If the topic of AIS is new to you, simply turn the page and start reading from Part 1. You can jump right into the information about satellites in Part 2, or if you already have a grasp of the subject and you want to know more about exactEarth's services, check out Part 3. For more about the many applications of S-AIS, Part 4 is your port of entry. And to read some concrete examples of exactEarth technology in action, set a course for Part 5.

Bon voyage!

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

# Part 1

# Exploring the Automatic Identification System

### In This Part

- Knowing what AIS stands for
- Introducing AIS
- Seeing how the technology works
- Unpacking AIS messages
- Meeting types of AIS devices
- Seeing the safety features
- Remembering AIS limitations

This part discusses the basics of AIS technology to give you an understanding of what the heck it is, how it works, and why it's beneficial. And you get the straight truth about the system's limits, along with some guidance on how they can be overcome.

## AIS: Acronym Introduction Section

If you remember only one acronym in this book, remember this one! The *Automatic Identification System* (or AIS) is an essential part of maritime safety.

The familiar idea of two ships that pass in the night is a little sad in the poetic sense, but in reality, that's exactly what ships should do. AIS was designed to prevent ships at sea from colliding, by allowing them to know the locations of nearby ships.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

# Knowing What AIS Is For

A vessel's personnel use AIS to ensure the safety of the ship, and maritime authorities use AIS to track ships and monitor where they are and where they are going.

AIS is a communications system based on *radio frequency* (RF), which is a form of wireless communications that uses the transmission and reception (sending and receiving) of electromagnetic waves. These waves work very much the same as do wireless transmissions from and to cellular telephones.

A ship's AIS *transponder* (the device that sends and receives signals) uses a *very high frequency* (VHF) RF transmitter to broadcast important information to receiver devices on other ships or land-based systems. By sending and receiving regular communications about their identity and course, vessels can avoid collision and navigate safely, even when they can't see each other.

Today, AIS transponders are so prevalent that the data they transmit and receive has become increasingly valuable, and not just to the vessels themselves. Naval forces, port authorities, coast guards, and other marine authorities use AIS data to improve their awareness of the current maritime situation.

## AIS ahoy!

Since 2004, the International Maritime Organization (IMO) has required AIS transponders to be aboard most vessels. The Safety of Life at Sea (SOLAS) Convention, Chapter V, states: "All ships of 300 gross tonnage and upwards engaged on international voyages and cargo ships of 500 gross tonnage and upwards not engaged on international voyages and passenger ships irrespective of size shall be fitted with an automatic identification system (AIS)."

More than 60,000 ships worldwide have installed these transponders at a combined cost of several hundred million dollars, making AIS one of the most successful maritime technology deployments of all time. Equipment that uses AIS technology is increasingly being deployed in smaller vessels, as well as radio/AIS-enabled aids to navigation (AtoNs), and it is also being installed on search and rescue (SAR) vessels and aircraft.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

# Discovering How AIS Works

Even though you can't see the signals, AIS isn't magic; it's *a*dvanced, *i*nteresting, and *s*ophisticated (get it?) technology that is used all over the world.

This section discusses how AIS devices share information with other ships and land-based systems. You also find out about the strategy AIS uses to organize all of these signals and get the timing just right.

## Broadcasting information

AIS devices send out information about the ship automatically and regularly, typically every few seconds.

AIS transponders on nearby ships or on land (for example, a vessel traffic services system) receive these signals. The information is displayed either on radar or on a chart plotter, showing ships' positions and call sign information.

When other ships and maritime traffic services know these key details, they can use them to ensure ships are following a safe course and to prevent collisions. So ship personnel don't need to physically see where other vessels are located in order to avoid them.

AIS combines technologies. It integrates a standardized VHF transponder with a positioning system, such as a long-range navigation system or *global positioning system* (GPS) receiver, with other electronic navigation sensors, such as a gyrocompass or rate-of-turn indicator.

## Using time slots

The preceding section mentions how AIS communications happen regularly and automatically. Here, you can find out more about how that works.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

### TDMA

AIS communications are based on a *time division multiple access* (TDMA) system, which permits each device to communicate during a given time period, or *time slot*. So the signals aren't being transmitted continuously, but only during their own time slots.

TDMA is the original communications system that cellular telephones used to use, except that cell phones had continuous communication with the cell tower — imagine trying to have a conversation if they hadn't! But ships aren't always within range of a tower, so TDMA was not the complete answer.

Each ship must have its own time slots to broadcast within. If they don't, ships within close range of each other would constantly be competing for the same time slots when sending their position reports, and the AIS messages would be lost because of the resulting interference.

### SOTDMA

*Self-organizing TDMA* (or SOTDMA) is the system that ensures AIS communications happen in an orderly way. It's like making sure you make a reservation before going out to the best restaurant so that you don't end up hungry.

Before an AIS transmitter is able to transmit, it first listens to the AIS frequencies to build a picture (a *time slot map*) that indicates the slot locations of other nearby AIS transmitters. With this information, an AIS transmitter knows that when it does transmit, it won't interfere with another AIS transmitter.

Furthermore, with SOTDMA, the AIS device has to announce ahead of time which time slots it will use, and it can't use the slots that have been reserved by another device. Think first come, first served — SOTDMA plays fair.

So by listening first, the AIS transmitter knows where other transmitters are and which slots they're reserving next. To make this fair, the slot selection is random, and each selection has a random *timeout* (the length of time the AIS transmitter will be permitted to continue to use the time slot). In this way, every device that receives the "preannouncement" notes that

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

those time slots have been taken, and then knows to choose different time slots to transmit its signals. SOTDMA is a very polite technology indeed!

This system allows the AIS devices to organize transmissions around each other in both an efficient and a non-interfering basis. Again, thinking back to cellular wireless communications, the limited range of these AIS signals over the ocean creates a cluster, or cell, of ships with AIS transmitters within communications range (so all ships can hear and be heard by other vessels). Within such a cell, these organized prearranged time slots and timeouts create an AIS *communications cell*. Figure 1-1 illustrates a communications cell made up of time slots. Depending on the ship's speed and where it is going, the SOTDMA protocol will adjust the number of reporting time slots required, making time slots from as little as two seconds for fast-moving ships to up to three minutes when at anchor.

As vessels move, they may need to change their time slot assignments. So when an AIS device changes its time slot, it preannounces both the new time and the timeout for that location. Quite clever!

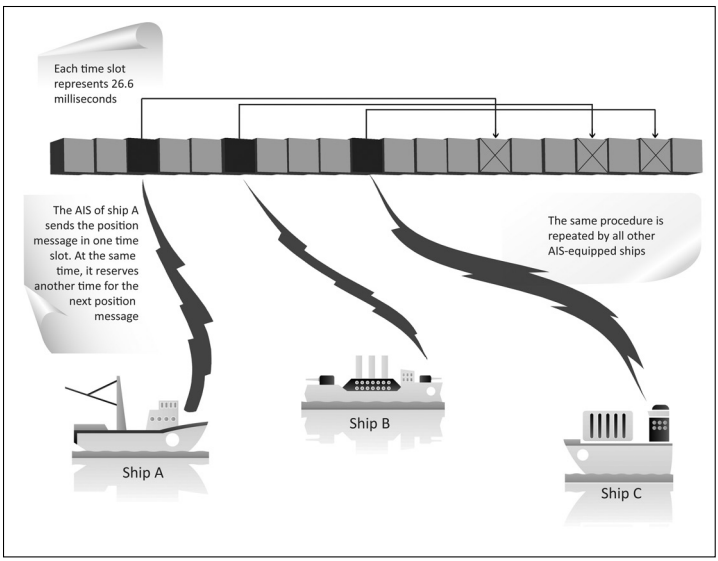

Each time slot represents 26.6 milliseconds
The AIS of ship A sends the position message in one time slot. At the same time, it reserves another time for the next position message
The same procedure is repeated by all other AIS-equipped ships
Ship A
Ship B
Ship C

**Figure 1-1:** A communications cell is made up of time slots.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

### When slots collide . . .

The term *maritime traffic* is used for a good reason: Because so many vessels are coming and going, things can get really busy on the ocean (imagine your morning commute without the traffic lights and paved roads!). And just like on a busy highway, with so many vessels passing in and out of AIS communications cells, the possibility of *slot collision* (more than one AIS device attempting to use the same time slot) does exist.

But just because slots collide, it doesn't mean that vessels will. Slot collision doesn't affect the AIS's main goal of keeping ships safe. The ship that is closest will always have a stronger signal, ensuring that the more important AIS message, from the closer ship, will be received correctly.

But what slot collision can affect are the stations that may be able to receive signals from more than one AIS communication cell simultaneously, such as AIS base stations along coastlines and receivers on satellites. When an AIS station does receive AIS messages from different AIS transmitters that overlap in a single time slot, a collision will corrupt both originating messages at the receiver. From space, where many hundreds of such AIS communication cells can be heard, the likelihood of message collisions increases very rapidly. Without some form of decollision technology, the resulting AIS receiver can quickly become overwhelmed with colliding AIS messages.

## Looking at What an AIS Message Contains

AIS messages contain a whole lot of information about a vessel, including details such as the following:

- Course
- Position
- Rate of turn
- Speed

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

And in some cases, AIS messages may also send other information:

- Destination
- Estimated time of arrival (ETA)
- Ship name
- Type of vessel

# Checking Out Types of AIS Devices

Several types of AIS devices exist, and they all interact with each other using AIS protocols and international performance standards. Having standards and protocols is important to make sure that all these devices are "speaking the same language" and able to communicate with each other.

This section tells you about some types of AIS devices and what they must be able to do.

The class of AIS device required to be carried on a particular vessel depends on the mandate the vessel falls under. For example, all vessels that fall under the International Maritime Organization's mandate must carry Class A devices. Individual countries tend to require a mix of Class A and Class B devices, depending on the function and size of the vessel. Vessels that voluntarily carry AIS can carry any class of device, but they tend to carry Class B most often.

## Class A

Class A devices are found on board vessels, and they are *transceivers* (meaning they pull double duty and can transmit and receive signals) that operate using SOTDMA. See what the device looks like in Figure 1-2.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

*em-trak Marine Electronics Ltd.*

**Figure 1-2:** Class A AIS device

Class A devices must do the following:

- Work with the ship's radar and display systems
- Have an integrated display
- Transmit at 12.5 watts
- Be able to work with many of the ship's systems
- Offer advanced features and functions

## Class B SO

Class B SO devices (as in, it's great to *be so* curious about AIS!) are also located on board ships and are transceivers using SOTDMA. In Figure 1-3, you see what they look like and how they're a bit different from Class A devices.

Class B devices must do the following:

- Work with the ship's radar and display systems
- Have an integrated display
- Transmit at 5 watts
- Be able to work with many of the ship's systems
- Offer advanced features and functions

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

*em-trak Marine Electronics Ltd.*

**Figure 1-3:** Class B AIS device

## Class B CS

Class B CS devices are located on board ships and are transceivers, but they work using *carrier-sense TDMA* (CSTDMA), which is restricted to a single time slot for transmissions. Here are the other features of Class B CS:

- Are not required to have an integrated display, but must be able to connect to most display systems
- Transmit at 2 watts
- Have a default transmit rate of every 30 seconds (but this may vary according to the ship's speed or special instructions from base stations)
- Have integrated GPS
- Be able to receive all types of AIS messages

## AIS SART

A *search and rescue transponder* (SART) is a device that likes to play the hero. A SART uses AIS technology to find vessels in distress. It intermittently sends a position report and safety text message; however, it does not have a receiver. SARTs don't give up easily, and they continue to send signals for 96 hours after they've been deployed. They transmit at 1 watt.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

## AIS aids to navigation

*Aids to navigation* (AtoN) are markers that help ships travel successfully, such as buoys. AtoN can be used by an AIS station to display its location on charting and radar systems. A station can then also transmit important information about weather and sea conditions to help vessels navigate safely.

AIS AtoN devices can transmit at 1 to 12.5 watts, with transmission intervals of between one and three minutes. Two kinds of AIS AtoN devices exist: those that receive signals only through reserved time slots, and those that can send and receive through SOTDMA.

## AIS base stations

AIS base stations are fixed (non-mobile) stations that maritime authorities use to monitor and control vessel traffic. These base stations can also control other AIS devices, and have the following capabilities:

- Turn other AIS devices on or off
- Reserve time slots for special transmissions
- Control which time slots mobile AIS devices use
- Control the power level of mobile AIS devices

### Going coastal

Port authorities and coast guards have a real interest in knowing about ship movements, so it's not just the vessels that have gone into the AIS game. Many coastal AIS stations are being built to improve safety and security for a country's shoreline. These systems are expensive to build and maintain, but they allow authorities to monitor vast areas of shoreline that, prior to AIS, needed far more costly systems to monitor.

In general, coastal AIS has a range of about 50 nautical miles (see the end of this part for more about this), but the coverage area can be shorter, depending on a few factors:

- Site of installation
- Height of the antenna
- Volume of traffic in the area (which could lead to slot collision)

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

Though AIS transponders use "self-organized" time slots using SOTDMA, the base station is able to further impose even more efficient SOTDMA organization within its vicinity, ensuring communications in busy harbor areas.

## Considering the Safety Benefits of AIS Technology

If you're a safety-first kind of person, you may have flipped directly to this section. If you read through the rest of this part, you already know the main purpose of AIS is to prevent vessel collisions. But this technology also includes a host of other safety benefits:

- **X-ray vision:** Well, sort of. Ships know the locations of all surrounding vessels, even when they can't actually see each other. That's because, unlike radar, AIS signals can actually "see" behind islands or around river bends by simply repeating the signal. So no ship can play a game of hide-and-seek; even when a vessel seems to be invisible, AIS can detect it and know where it is, which makes navigation safer and prevents collisions.
- **Guide the way:** Aids to navigation (AtoN) devices transmit AIS signals. This includes even physical aids such as buoys. (You can find out a bit more about AtoN in Part 4.)
- **Signals from ship or shore:** Either on-ship or shore-based stations can issue safety messages. So a ship that is adrift can broadcast an "adrift with no engine" warning, stations can issue storm warnings to vessels, and ships can issue search and rescue information for emergency assistance.
- **Neither rain nor sleet:** AIS signals can be sent and received even in very poor conditions, such as in nighttime heavy rain, in fog, or during snow squalls.

## Noting AIS Limits

AIS is a widely used maritime technology that has become important to maritime authorities around the world. But it's precisely the part about a round Earth that presents limitations for this system.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

## The 50-mile barrier

Some say that the sky's the limit, but in this case, it's actually the *horizon*. Because the Earth is round, AIS doesn't have unlimited range. Its signal transmission is limited to approximately 50 nautical miles. Imagine watching a ship sail off into the sunset on the horizon. If you keep watching (and if you have super-powered glasses that give you exceptional vision), eventually the ship will seem to disappear as it follows the curvature of the Earth.

This range limitation can prevent maritime authorities from getting a complete picture of maritime traffic outside of their borders and on a bigger scale.

## Breaking the 50-mile barrier

To be most effective and to operate as safely and efficiently as possible, authorities want to be able to know as much as they can about vessel traffic over the widest area possible. So how can they do this? You can find the solution not at sea, but in space! Part 2 explains more

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

# Part 2

# Satellite AIS: Alerts from Space!

### In This Part

- Using satellites with AIS technology
- Seeing more from space
- Looking at the two ways to detect signals from space

Part 1 tells you about the *Automatic Identification System* (AIS) and how it is essential to maritime safety. But it also acknowledges that this technology has its limits; namely, that AIS signals can't reach beyond about 50 nautical miles. This is because the AIS signal travels in a straight line while ships follow the curvature of the Earth, so eventually the ship drops out of view.

Of course, innovation is all about going beyond barriers, whether they extend to 50 nautical miles or the other side of the world. In this part, you find out how using satellites with existing AIS technology gives a comprehensive picture of vessel activity, even in high-traffic and remote areas.

## S-AIS: Out of This World

Do you use a smartphone? Have you ever gone online to check out the forecast for a day at the beach? Used a *global positioning system* (GPS) device to find your way around a new city? Listened to the radio? If so, the chances are good that you've made use of satellite technology.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

*Satellite AIS* (S-AIS) greatly extends the range of traditional AIS (refer to Part 1). As Figure 2-1 illustrates, signals are sent and received from many kilometers above land and sea, so the barrier of the horizon doesn't limit these signals.

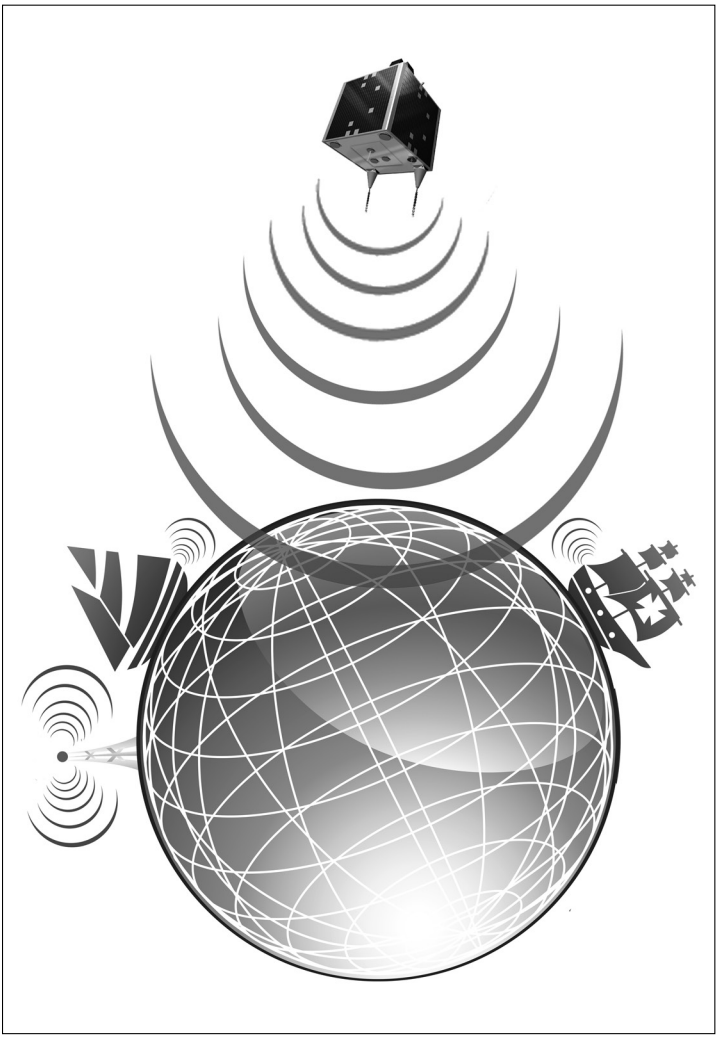


**Figure 2-1:** The extended range of S-AIS signals

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

With AIS, devices need to be fairly close together to communicate. But S-AIS removes these barriers, and authorities get a much more complete picture of maritime activity in the areas in which they're specifically interested. This provides many benefits, including the following:

- Improved ability to identify potential threats
- Better monitoring of vessel traffic patterns
- More cost-effective use of assets

A bonus to getting the bigger picture is that S-AIS can be implemented without additional hardware upgrades — vessels and stations are already outfitted with AIS technology!

## Getting the Big Picture with S-AIS

An increased need exists to get the complete picture of what's happening in authorities' territorial waters, including areas that are distant and isolated from ports and shorelines.

Think of trying to put together a jigsaw puzzle with crucial pieces missing. It's frustrating, and you don't end up with the whole picture. That's kind of what it's like when maritime authorities attempt to get a complete picture of activity on the water without using S-AIS — without satellites, they're always missing pieces of the puzzle!

The initial idea for AIS was to prevent collisions between ships (refer to Part 1). Using AIS technology, vessels within close proximity of each other send signals to form a communication cell, and each ship has its own time slot to prevent messages from getting mixed up, or colliding.

A satellite can detect many of these communication cells at the same time. It can capture thousands of individual ships' signals all at once.

Part 3 contains an overview of how exactEarth's patented technology uses groups of microsatellites to provide a complete picture of ships' activity in even the most remote areas

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

of the world's oceans. Satellites take all the mystery out of these little-explored regions.

# Seeing the Two Types of S-AIS

Detecting S-AIS signals can be done in two ways. This section looks at both of these methods for getting messages from space.

## On-board processing

*On-board processing* (OBP) uses specialized receivers on satellites that work a lot like the standard AIS receivers on Earth, but they are more sensitive.

OBP doesn't require special processing and works well in very low-density areas, such as the Pacific Ocean where there is little traffic.

However, OBP may not be as effective in detecting signals in areas that contain more than 1,000 ships, because of the slot collisions that high density can cause. This means OBP may not detect all messages during its first pass, or orbit, of an area, and may need to go over an area several times before it assembles a complete picture.

And if a given area has quite a heavy volume of ship traffic — more than 2,500 vessels — OBP will have an even harder time giving a full, accurate picture. That's because with so many signals, slot collisions will occur, and OBP isn't capable of resolving colliding messages.

The reason slot collisions occur is because the satellite is seeing multiple cells. Within a communications cell, an AIS device's slot selection is randomized and tagged with a random timeout. When an AIS unit changes its slot assignment, it announces the new location and the new timeout. As vessels pass in and out of communications cells, the chance of slot collision grows. But because two channels for backup exist, and because the closer vessel is always heard first, slot collisions don't affect the primary purpose of AIS — collision avoidance. However, slot collisions do affect receiver stations, which may hear multiple communication cells simultaneously;

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

for example, signals from AIS base stations on land and from satellites. (Refer to Part 1 for more details.)

## Spectrum decollision processing

In *spectrum decollision processing* (SDP) the satellite listens and captures all AIS signals from across the AIS radio frequency spectrum. It then transmits all this information to Earth without trying to make sense of it. After the info is received on Earth, powerful computing is applied to sort out all the AIS messages from the noise of all the cells. It processes all of the information and decollides all the messages that were received simultaneously from vessels using specialized algorithms. This method allows for the most ships to be detected.

SDP works very well for areas with heavy maritime traffic, and it is important for detecting enough messages to get S-AIS working effectively.

The first time a satellite with SDP technology passes over a given area, it can get a nearly complete picture of what's going on down on the water, even in high-density areas with thousands of ships. So you are able to get an accurate picture of maritime activity much more quickly.

Imagine you are James Bond on a mission. You are hiding out above a huge dining hall, spying on the diners below so you can get some top-secret intelligence. Hundreds of people are talking at once, and the noise of all these conversations is blending together. If you, as James Bond, were working like an OBP satellite, you'd have to try to interpret every voice and conversation from the rest of the noise by listening, trying to identify who said what, writing everything down as fast as you could, and then sending your notes, which likely didn't capture much, back to M at the Secret Intelligence Service. Using this method, you'd miss a lot of information. But if you had a special listening device that worked just like an SDP satellite, you could sweep up all the noise and send it back to voice recognition systems, which would extract every individual conversation while you visited the casino to break some hearts.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

# Part 3

# The exactView System

### In This Part

- Introducing exactEarth's solution
- Saluting microsatellites
- Stepping up to the technology platform

The first half of this book helps you to understand how the Automatic Identification System works, and how using satellites with this technology creates even more possibilities for maritime authorities and other organizations to keep vessels safe.

This part introduces you to exactEarth's own technology for Satellite AIS (S-AIS): the exactView system.

## Understanding exactEarth's Technology

exactEarth uses its own global satellite system and a patented advanced S-AIS detection technology. This unique technology has been developed to collect, process, distribute, and archive AIS messages received from ships all over the world.

In Part 2, you can read about how it's possible to sort out and extract data from AIS signals, even when thousands of these signals are being received from one area. exactEarth's technology calmly handles the incessant ship chatter through its customized algorithms that put overlapping signals in their right place — even in the most crowded, high-traffic maritime areas.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

With exactView, you get the most accurate picture of maritime activity, no matter how many AIS messages are competing to be heard.

# Microsatellites, Macro Benefits

exactEarth's technology works by using a *constellation* (essentially a group) of microsatellites that orbit the Earth. See Figure 3-1 for a look at this technology. These microsatellites are always in motion, passing over different areas as the Earth rotates, and will complete an orbit in approximately 90 to 100 minutes.

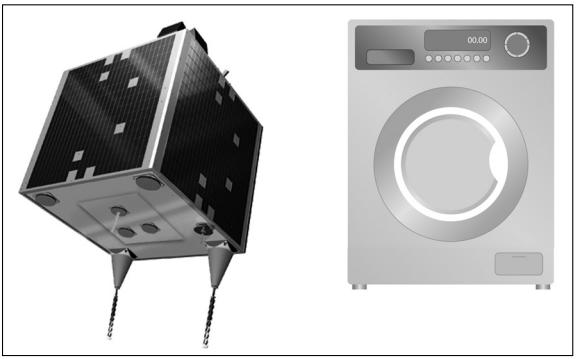


**Figure 3-1:** Microsatellites

While a traditional satellite is generally quite large, and weighs into the tons, a typical microsatellite weighs around 100 kilograms (about 220 pounds). And, believe it or not, even smaller satellites exist, called *nanosats* and *cubesats*, weighing in at around 10 kilograms (22 pounds). exactView includes both microsatellites and nanosatellites in its constellation.

## Small is smart

Microsatellites have many advantages over their bulkier brothers:

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

- **Cost:** They can be designed, built, and launched for a fraction of the cost of traditional satellites.
- **Time:** They can be completed within a much shorter time frame.
- **Technology:** Because these smaller satellites cost less and are quicker to build, operators are more willing to use leading-edge electronics or software that can be considered too risky to deploy on costlier, larger satellites.

Microsatellites are ideal for wide-area surveillance, environmental monitoring, or remote-area tracking.

## Collecting the data

The satellites' job is to collect the AIS transmissions from every ship that is within the satellite's field of view. These small satellites have a vantage point of about 650 kilometers (or about 404 miles) above the surface of the Earth, which is considered a *low-earth orbit*. But don't let the word *low* mislead you — that's low by satellite standards! Microsatellites have an enormous field of view, approximately 5,000 kilometers (3,107 miles) in diameter.

Microsatellites' low orbit allows them to detect transmissions from lower-powered equipment that is at either ground or sea level.

# Meeting exactEarth's Technology Team

As a leader in global S-AIS vessel tracking, exactEarth collects more ship monitoring data than similar organizations and delivers the highest quality information to customers around the world. This information gives a better awareness of the maritime situation to governments and commercial organizations, whether they're tracking a single vessel or monitoring vast areas of ocean. Figure 3-2 maps out the journey of S-AIS signals through exactEarth technology.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

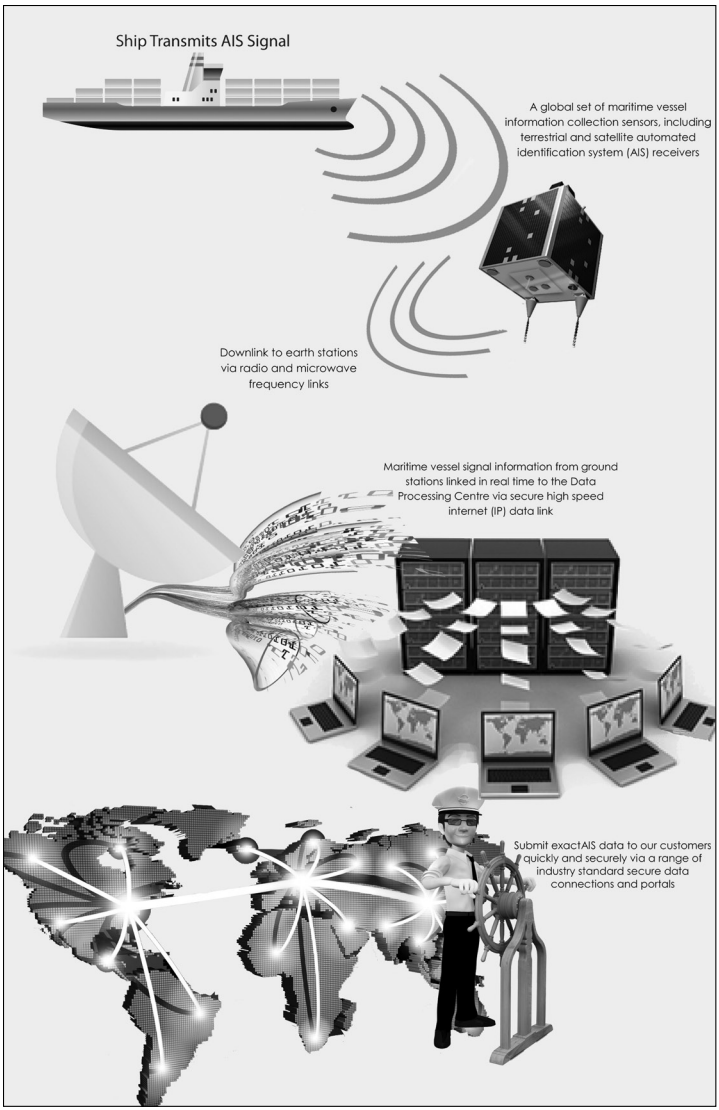

Ship Transmits AIS Signal
A global set of maritime vessel information collection sensors, including terrestrial and satellite automated identification system (AIS) receivers
Downlink to earth stations via radio and microwave frequency links
Maritime vessel signal information from ground stations linked in real time to the Data Processing Centre via secure high speed internet (IP) data link
Submit exactAIS data to our customers quickly and securely via a range of industry standard secure data connections and portals

**Figure 3-2:** S-AIS signals travel from ship, to space, to ground, to customer.

Not all vessel tracking organizations provide a full range of services, but exactEarth does. exactEarth combines innovative technology with traditional customer service to deliver a global maritime picture. Here are the elements that make up the exactView technology platform:

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

- **AIS transponders:** These transponders are the source of the data for the exactAIS service. Because they're already installed aboard 60,000 vessels worldwide, no changes to existing onboard equipment or procedures are required, which saves time and money.

  exactView is a sensitive and powerful system that can also detect signals from lower-power units, such as many search and rescue transponders (also called AIS-SART).

- **Satellite payloads:** These are receivers that are designed to detect AIS signals that sit aboard the satellites of the constellation. Think of these as the "ears" of the technology.

- **Earth stations:** (Also called ground stations, antennas, or dishes.) Earth Stations receive and/or transmit data to satellite platforms and can communicate with many different satellite types. Many ground stations receive data from the satellites as they pass overhead on every orbit, several times a day. After the data is *downlinked* (or the signals get sent from space to Earth), it is then sent, fully encrypted, to the exactEarth data processing center.

  More and more ground stations (see what they look like in Figure 3-3) are being used around the world, and new stations are being developed for even faster data flow.

**Figure 3-3:** A ground station

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

As satellites orbit the Earth, they collect data and transmit that data when they are in sight of a compatible earth station. A satellite passes within sight of an earth station many times within an hour, so a lot of data must be downlinked in a very short time. The exactEarth satellites use a dedicated high-speed downlink channel for AIS data to ensure that all collected data is retrieved.

- **Operations center:** Equally important to collecting all the data is that the right information gets to customers when they need it. The operation center manages collecting S-AIS data from the satellites and then ensures data is configured and distributed to the appropriate data feeds across the globe.

Satellites don't sleep, and so the operations center is monitored 24/7!

- **Data processing center:** Security and reliability are also essential to getting the most out of S-AIS technology. When data is sent from a satellite to an earth station, it is transmitted to the data processing center. It's a fully secured computer facility in Toronto, Canada.

The following systems are in place at the center to prevent any interruption or loss of data:

  - Fail-safe grid power feeds
  - Dependable diesel generating systems
  - Reliable cooling systems
  - Guaranteed fire suppression systems
  - Consistent fiber-optic connectivity to the Internet
  - Physical security personnel on-site

- **Customer delivery:** exactAIS data is delivered to competent maritime authorities over encrypted data links, in a variety of formats, including the standard National Maritime Electronics Association (NMEA), Over-the-Horizon-Gold (OTH-Gold), and Keyhole Markup Language (KML) formats and in CSV plain-text data format. exactAIS data is also available as an Open Geospatial Consortium (OGC)–compliant Web Map Service and Web Feature Service.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

If exactView got a report card, the teacher would indicate that it plays well with others. It can easily integrate into different kinds of geospatial platforms and mapping systems. Also, customers can choose how to view their data. They can select an interface that works with their existing display system, a web-based display, or another complete ready-to-use solution.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

# Part 4

# The Versatility of S-AIS

### In This Part

- Seeing the many applications of S-AIS
- Keeping tabs on vessels
- Improving search and rescue
- Enhancing safety of people and governments
- Watching out for the environment

Satellite AIS (S-AIS) technology is many things, but it doesn't have a one-track — or rather, one-signal — mind. Sure, it can track ships and keep them safe, but this is only the tip of the iceberg. S-AIS can be used for a huge number of purposes, and this part explores the possibilities and the many applications for this technology.

## Recognizing Uses for S-AIS

Previous parts of this book explain how S-AIS technology is ideal for detecting and tracking ships. This capability, however, has helped chart new courses for the technology such as the following:

- Monitoring vessels and the waters they navigate
- Enhancing search and rescue operations
- Ensuring the security of people, business interests, and borders
- Protecting the environment

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

# Vessel Tracking

Knowing where ships are and where they are going, even if it's to the most remote places, has a host of benefits for maritime authorities and other organizations. Here, you find out about the ways Satellite AIS enhances vessel monitoring.

## Safer ship routing

Maritime traffic isn't quite as busy as on the expressway you drive to work, but it certainly is getting busier every year. Ships are under a lot of pressure to deliver their cargo on time, and they need safe and secure routes to do so.

S-AIS can monitor vessels globally, with a reach that is far greater than radar or coast-based AIS systems (refer to Parts 1 and 2 for more). It can automatically monitor a defined area or predetermined route, and warn maritime authorities if a vessel appears to be going off course. The S-AIS data about the ships can be combined with data about weather conditions or other conditions on the ocean, so maritime authorities can alert ships to change course and completely avoid dangerous areas.

## Enabling VTMIS (Vessel Traffic Monitoring and Information Systems)

VTMIS enhance the safety and efficiency of maritime traffic, because they allow authorities to respond to incidents, accidents, or dangerous situations much more quickly.

Seeing the big picture of maritime traffic means authorities can oversee all vessels more closely. S-AIS gives this big picture. This way, authorities can make sure ships are following maritime regulations, recommendations, and safe practices. They can also use system data to know if vessels are heading into bad weather and warn them.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

## Ship reporting

Many countries have mandatory or voluntary ship reporting systems, which give critical information for traffic monitoring, search and rescue, environmental protection, and customs and immigration. The problem is that the reports may not always be correct or complete, because some ships don't take the time to do the required manual reporting.

But all reporting with S-AIS is done automatically, so there's no need for manual reporting. This means the data is complete and correct with each report.

## Remote region monitoring

Monitoring remote region shipping in areas like the Arctic or coastlines of Africa is often a challenge, because the coastline is rather uninhabited with little or no industrial development. Infrastructure and systems are simply not in place in these regions as they are elsewhere in the world.

S-AIS is ideally suited to monitor such remote regions and provides a unique insight into shipping activities that take place there. Figure 4-1 illustrates some of the information S-AIS can glean about this region.

exactEarth
exactAIS Arctic Archive
50 Vessels - September, 2011
A unique collection of vessel tracks across the Arctic from September, 2011. Vessels are from multiple Nations and include Cargo Ships, Tankers, Special Service Vessels, and even some Passenger & Pleasure craft. The tracks have been categorized by ship type, representing like Vessels in common colours.
LEGEND
50 Vessels - September, 2011
Cargo Ships
Tanker Ships
Special Services
Fishing, Research & Private Pleasure Craft
Passenger Ships
Others
ARCTIC OCEAN
MMSI 273210600
IMO 8227056
Call Sign UFJN
Length (m) 39.0
Width (m) 13.0
Ship Type Vessel,Fishing
Image More Info
Vessel Name VILNYUS
Zoom to
esri

**Figure 4-1:** S-AIS demystifies the remote Arctic.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

Using satellites, authorities can get a comprehensive view of Arctic maritime traffic trends, which they can use to design the safest and most effective shipping routes.

## Validation of ship declarations

When vessels pass in and out of different waters, they can carry and transfer harmful aquatic organisms. In addition to harming the water, around 870 million tons of sulphur and nitrogen oxides, ozone-depleting substances, and volatile organic compounds get into the air through ships' emissions. Although the International Maritime Organization (IMO) has several regulations to prevent such damaging effects, monitoring a vessel's compliance with declaration protocol can be difficult. Without S-AIS, maritime authorities need to rely on other, less efficient methods, such as periodic aircraft patrols.

Using S-AIS, maritime authorities can track a ship's time, position, heading, and speed, and they can also tell whether or not a ship made a required deviation in course. This can also be verified against the ship's log.

## Efficient vessel traffic services (VTS)

VTS was designed to improve the safety and efficiency of navigation, protect people's lives at sea, and protect the marine environment. It uses data about vessel traffic that comes from coastal and radar surveillance techniques; however, this data can be somewhat limited, and participating in VTS is voluntary in some areas. S-AIS provides coverage in coastal areas where radar would be too expensive, which extends vessel tracking services into more remote areas. This way, VTS is better able to help reduce the density of vessel traffic.

## Arrival management

Ships are required to give authorities a notice of arrival about 24 to 48 hours prior to arriving at port. With VTS, many agencies, such as the harbormaster and customs and immigration, use this information for daily activities.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

Managing arrivals can be quite complex. S-AIS can monitor ships that are far out to sea, so authorities can better plan ships' arrival times no matter where they're coming from. S-AIS also provides information to stakeholders of the port systems so they can be prepared for the time of arrival. Authorities can then schedule administrative requirements well in advance, improving wait times for vessels.

### Effective vessel traffic analysis

Hydrographic agencies need to analyze up-to-date ship traffic trends because sometimes areas that were once safe can change. But before S-AIS was used, charting activities in all bodies of water across the globe was not possible.

With this satellite technology, traffic analysis can be done in remote coastal and offshore areas, where it couldn't be done before — even in the most remote areas of the planet.

## Search and Rescue

Often, vessels don't report that they're in distress until it's too late — they send the distress signal at the last moment, or not at all. That leaves precious little time to coordinate a search and rescue effort. For successful search and rescue, people at the rescue coordination center need a current image of all vessels in the area so they can use resources efficiently and send help quickly. S-AIS data can make a big difference in search and rescue operations and, ultimately, save lives.

### Tracking and assisting distressed vessels

S-AIS acts like a first responder because it's well suited to assisting vessels in distress. Transmitted data identifies a vessel in distress — including its last known position — and can track a drifting vessel from the location of a distress call. S-AIS can also quickly identify which vessels are in the vicinity of a distress call, so that help can arrive as soon as possible.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

S-AIS technology can also enable maritime authorities to be proactive about search and rescue activities. The information provided by S-AIS (Part 1 tells you what goes into an AIS message) allows authorities to create behavior patterns of traffic and individual ships, and they can use this information to better plan daily search and rescue patrols that are most effective.

## Casualty alerting

Each year hundreds of maritime casualties are reported, including damaged vessels, loss of cargo, and, tragically, loss of life. Investigations try to determine the root cause of the incident and often point to vessels floundering after encountering heavy weather, grounding, or colliding with another vessel or object. Here are some common problems these investigations find:

- Poor navigation
- Loss of propulsion
- Structural failure
- Steaming too fast for the prevailing ocean conditions

S-AIS provides continuous coverage of vessels, even in harsh weather. It also lets authorities monitor the risk to traffic in areas of interest. This lets authorities intervene early and prevents serious incidents from happening.

## Natural disaster relief

Natural disasters, such as the devastating tsunami on the Pacific Rim in early 2011, bring massive destruction to coastlines and land and can also wreak havoc on surrounding waters and vessels in those waters.

Nasty weather and natural disasters mean bad news for traditional coastal surveillance systems, because these adverse conditions can disrupt signals. But S-AIS gives consistent coverage in all kinds of weather, over a wide area. With S-AIS signals, authorities can refine search areas when looking for people and vessels in distress, and compare a traffic image before and after a dangerous weather event to find survivors in the area.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

# Security and Surveillance

For maritime authorities, gazing out at their massive protection zones can be like looking at one big potential crime scene. Harmful, threatening, illegal activity may be happening anywhere. Satellite AIS can help bring vast monitoring zones down to a much more manageable size, lessening those risks for safer and more secure maritime activity.

## Piracy monitoring

Pirates may conjure up visions of kids' fairy tales, but modern sea piracy is a big international problem. According to the IMO, this problem costs about $7 to $12 billion each year.

Although more than half of pirate attacks happen around the Horn of Africa and the Gulf of Aden, piracy is also happening around Southeast Asia, South and Central America, the Caribbean, and West Africa.

S-AIS data provides the ability to detect changes in a vessel's velocity and any disparities between its *course over ground* (COG) and the ship's heading, which may indicate that a vessel is drifting or was pirated. By observing such factors, ship operators have the ability to alter their course when required.

S-AIS data can also be used to identify and analyze traffic patterns in highly pirated waters to help authorities determine safer shipping routes.

## Smuggling prevention

Incidents of maritime smuggling are on the rise. Drug trafficking overseas has practically become its own industry. Many sophisticated anti-trafficking strategies are established, but drug shipments are still making their way overseas.

One challenge that maritime security forces have to cope with is that the handoff of illegal drugs often happens out of the range of regular coastal AIS, so it goes undetected. But S-AIS can track large international vessels and note where they may stop or slow down unexpectedly, providing an indication of when a drug handoff may be taking place.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

## Mitigating infectious disease

Ships that travel across the globe are at risk of passing on human or animal disease not only to crew on board but also to anyone who comes in contact with the ship at port. Some kinds of cargo are also prone to infestation by rodents, insects, and their larvae. Even when precautions are taken, ships can still arrive at their port of destination with infestations or infections on board.

By tracking ships globally, S-AIS is able to locate ships traveling through infestation hot spots and can also validate a ship's declared voyage to ensure no deviations en route took place into diseased locations.

## Increasing vessel safety in hostile waters

Conflicts between countries can overflow into international waters, disrupting global shipping. Hostile military forces can threaten the safe passage of ships close to their shores.

The information monitoring authorities acquire through S-AIS helps to plan safe escorts and manage convoys to keep ships, cargo, and crews safer when in unfriendly waters.

During voice communication between vessels or between vessel and shore, a possibility exists that the wrong people can pick up on routing information or security plans. S-AIS data is encrypted and more secure than voice communication.

## Vessel identification with radar and digital imagery

Threats and illegal activities around borders are a problem for national governments — keeping their borders secure is a priority. The problem is even more complicated at sea because getting an accurate picture of maritime activity is more difficult. Some reasons are a lack of resources, inefficient surveillance techniques, and vast areas of oceans that are unmonitored and can be used by vessels to avoid detection.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

By fusing Satellite AIS with radar and digital imagery, authorities can put together a much clearer picture to know exactly who is in their waters.

Using radar and digital imagery gives data in real time. It makes identifying vessels more accurate because the S-AIS messages provide relevant information about the nearest ship — name, time stamp, course, and so on. With radar, even ships that have deactivated their AIS can be detected before and after the device is turned on and off, and then S-AIS can verify the ship's information. And by measuring the radar image against the AIS message, authorities can know a ship's length and width, so validating the ship is made easier.

## Monitoring aids to navigation operations

Many *aids to navigation* (AtoNs), such as buoys, are equipped with AIS that show their positions on vessels' bridge displays. S-AIS has much greater range than traditional VHF reception and covers all areas where remote AtoNs may be deployed. Using S-AIS data, authorities can send status reports and check on buoys or other AtoNs to ensure they're working properly. If they need maintenance, authorities are then able to schedule repairs and send a worker to fix any issues, as needed.

Deep-sea buoys can be quite large, and vessels can be in big danger if they can't detect a buoy's presence. By receiving status reports on AtoNs through S-AIS, authorities can know when a buoy is in an "off" position, and then quickly issue safety notices to mariners in the area so they can avoid collision.

# Environmental

Today, more than ever, the state of the environment is on the minds of governments, businesses, and individuals. Thanks to S-AIS, steps can be taken to control, preserve, and protect the world's natural resources.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

## Pollution control

Although dumping things in the ocean may appear to make them disappear and culprits assume the adage "out of sight, out of mind" applies, putting certain harmful substances into our oceans is actually regulated under the MARPOL Convention (also called the International Convention for the Prevention of Pollution from Ships). It prohibits ships from discharging harmful or dangerous substances, such as oil, noxious liquids, plastics, and ozone-depleting substances, into the ocean.

Find out more about MARPOL on IMO's website at `www.imo.org`.

Tracking vessels with S-AIS helps governments determine when prohibited discharge regulations are being violated. Through S-AIS, maritime authorities can confirm the positions and locations of ships recorded in the onboard logbooks and find any discrepancies in reporting.

Data collected with S-AIS can also point to other suspicious activity that may be related to pollution. If the data shows that a ship has deviated from its preset course, it may indicate that the ship is trying to hide prohibited discharge and avoid getting caught.

## Environmental preservation

Evidence is piling up that the state of the world's oceans and the marine life within them is declining. To try to improve the situation, many areas are designated as Marine Protected Areas or Particularly Sensitive Sea Areas. Access to these areas is strictly limited or forbidden to protect these fragile ecosystems from the harms of industrial activity.

As Part 2 discusses, S-AIS is perfect for monitoring ship traffic over large areas of ocean because it has a much bigger vantage point from space than land-based systems do. It can also zero in on a particular area and collect data about the activities taking place there. S-AIS can track and report on ships that are navigating into environmentally sensitive remote areas, areas that are out of the range of land-based AIS devices along the coast.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

## Fisheries protection

Fish populations across the world's oceans are in serious threat after decades of overfishing. Today, illegal and unregulated fishing is threatening to wipe out entire species.

With S-AIS, maritime authorities can validate a ship's reported position by comparing the latitude and longitude of the AIS coordinates. Authorities can then identify spoofed position reports of ships in commonly fished waters to see where illegal fishing may be taking place. *Spoofing* is when a ship purposely reports a position other than its actual position.

S-AIS also extends coverage into remote waters where fishing may not be permitted, so authorities can prosecute more violators.

Large *reefer ships* (ships that are able to freeze or refrigerate large quantities of fish) are used regularly as "mother ships" by pods of fishing vessels that are fishing illegally. Reefer ships are quite large and fall under the IMO mandate — they require a Class A AIS transponder (refer to Part 1). The reefer ships will anchor outside of EEZ (exclusive economic zone) coverage and act as a collection point for a group of smaller vessels that are doing the illegal fishing. Satellite AIS uncovers this scheme easily because it shows the pattern: many fishing vessels that stay generally in a small zone but return to an area where a reefer ship awaits its haul.

### Something's fishy

A report by the United Nations Fisheries and Agriculture Organization states that 53 percent of the world's marine fishery resources are either fully fished or fished to the maximum sustainable level. Another 32 percent of resources are overfished, depleted, or recovering.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

Even if the reefer ship turns off its AIS, you can identify the *illegal, unreported, and unregulated* (IUU) behavior from the ships that keep returning to the same point. If the fishing vessels turn off their AIS, again, you can determine that IUU fishing is going on because you can see a large reefer vessel at anchor in the middle of the ocean.

If ships turn off their AIS, they become targets for investigation simply because they aren't using AIS.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

# Part 5

# exactAIS in Action

### In This Part

- Monitoring ships in the Arctic
- Saving lives
- Fighting pirates
- Overseeing protected areas

This part makes the case for exactAIS data. It takes you through four concrete examples of this technology to help broaden your own view of the sorts of benefits that exactAIS has to offer.

## Vessel Monitoring Case Study: Arctic Monitoring and Shipping

Although this enormous region was once rarely explored, the Arctic Ocean is becoming more important than ever before. That's because as sea ice melts a little more each year, the region opens up to more and different kinds of development, and shipping in the Arctic becomes a bigger business all the time.

This area is seeing more commercial ships, tourist cruises, research ships, coastguard icebreakers, exploration survey ships, and fishing fleets. The area is rich in mineral resources and aquaculture. Passenger vessels give people access to the spectacle of sea ice, research vessels search for minerals, supply vessels serve mineral extraction installations, and tankers and bulkers transport minerals and extracted resources.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

## Opening new routes

Retreating ice is opening up the Canadian Northwest Passage and the Russian Northern Sea Route to regular commercial shipping, which can perhaps have the biggest effect on shipping in the region. See the vessel tracks from 2011 in Figure 5-1.

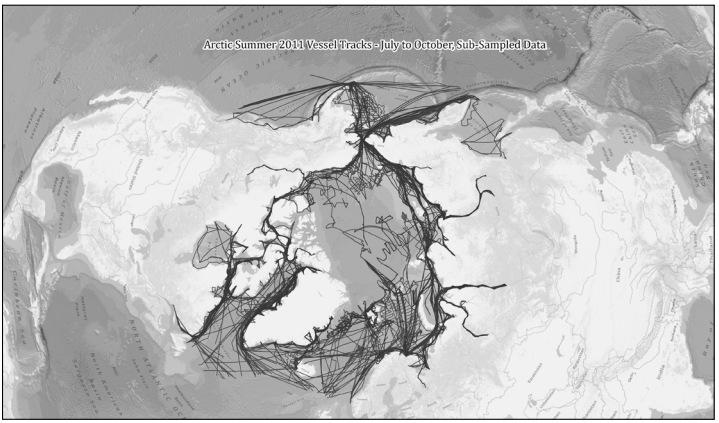



**Figure 5-1:** Arctic vessel tracks in 2011

### Under the ice

You've heard of global warming, but did you know that Arctic regions are warming at around twice the rate of the rest of the planet? As the Arctic ice melts and its landscape changes, relations among humans are also being affected as this region becomes more accessible than ever before. Countries and industries, such as oil and gas, are strategically making claims to the Arctic land and its natural resources. Researchers are lobbying to study the region, and visitors want to explore this mysterious place. All this new interest in the Arctic is big news for the shipping industry. This means getting an accurate picture of the Arctic is more important now than ever.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

Both the Canadian Northwest Passage and the Russian Northern Sea Route are good alternatives to already-established sea routes. The journey by ship from North America's Pacific Coast to Western Europe is one-third shorter using the Northwest Passage than by using the traditional Panama Canal route. Using the Russian Northern Sea Route offers shipping an alternative to the Asian/Western Europe route and avoids the potentially dangerous Suez Canal route and the incredibly long voyage around the African Cape.

## On thick ice

Monitoring and understanding the changes in Arctic ship traffic is vital not only to provide reliable information to safely guide Arctic shipping in the future but also to understand what effects all this activity will have on this fragile and rapidly changing ecosystem.

A heightened risk to the safety of aquatic life and damage to the sensitive environment are caused by the increased numbers of vessels involved in Arctic tourism, mineral extraction, fishing, and the transportation of goods. Furthermore, the ability to monitor traffic and respond to incidents is severely restricted because of the climatic conditions and limited rescue resources.

The region is also notorious for its poor visibility for vessel traffic. Arctic regions are some of the most hostile maritime environments on the planet, for reasons such as the following:

- Ice can accumulate on vessels, leading to instability.
- Ships are in danger of colliding with icebergs and growlers (smaller icebergs), which are not easily detected by radar.
- Sea ice is thick in winter and can pile up in summer months, making certain areas impassable.

To make Arctic regions easier and safer to navigate, an International Code of Safety for Ships in Polar Waters (Polar Code) is being developed, with support from the International Maritime Organization (IMO). The Polar Code requires all vessels traversing these waters to be equipped with AIS.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

## How S-AIS helps

Monitoring Arctic activity is a challenge. The coastline is remote and uninhabited, with little or no industrial development. Infrastructure and systems are simply not in place as they are elsewhere in the world. S-AIS technology is making travel, tracking, and shipping through Arctic regions much safer than ever.

S-AIS is ideally suited to monitoring remote regions. The data collected provides safety agencies, national authorities, commercial companies, and research institutes with new insight into ship traffic movements. This helps to analyze risk to vessels, the environment, and individuals' safety. Here are some examples of the benefits of exactAIS in the Arctic:

- exactAIS is able to receive AIS outside the coverage of coastal AIS and is particularly advantageous in areas where coastal technology is too expensive.
- The data gives authorities the ability to monitor the vast region and identify ships traveling through remote areas, where previous surveillance systems had limited or no detection.
- exactAIS is easily integrated with data that forecasts weather and ice conditions, which enables the implementation of vessel traffic monitoring and information services (refer to Part 4 for more on VTMIS), especially for the northern sea passages, to allow vessels to navigate safely even in the area's heavy fog conditions.
- exactAIS allows for critical tracking of passenger ships in Arctic waters to ensure they're following the directions of coastal state authorities and adhering to important safety measures.
- Data also enables authorities to monitor other vessels that are traveling in the vicinity of passenger ships, in case they may be required to take on passengers in a rescue operation.
- exactAIS provides more frequent AIS coverage over the Arctic region than any other system by delivering a better understanding of Arctic maritime traffic trends.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

# Search and Rescue Case Study: Casualty Alerting

Shipping is essential to the global economy because it's likely the most international of all the world's great industries, but it's also one of the most dangerous.

Each year, hundreds of maritime casualties occur; vessels sustain damage, cargo is lost, and, tragically, people lose their lives.

## Safer shipping

The world's oceans are vast, and incidents happen for many reasons. The effects of marine accidents aren't limited to just humans; they also involve marine creatures and the marine environment and ecosystem.

The investigations that are launched to determine the root cause of these incidents often point to the following problems with vessels:

- Floundering when encountering heavy weather, grounding, or colliding with another vessel or object
- Navigating poorly
- Losing propulsion
- Having a structural failure
- Steaming too fast for the prevailing ocean conditions

Although new safety standards are emerging, shipping is, and always will be, full of risks. But internationally adopted standards for ships, mariners, and shipping management are improving shipping safety for safer business and cleaner oceans. You can see the navigation behavior of a ship in distress in Figure 5-2.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

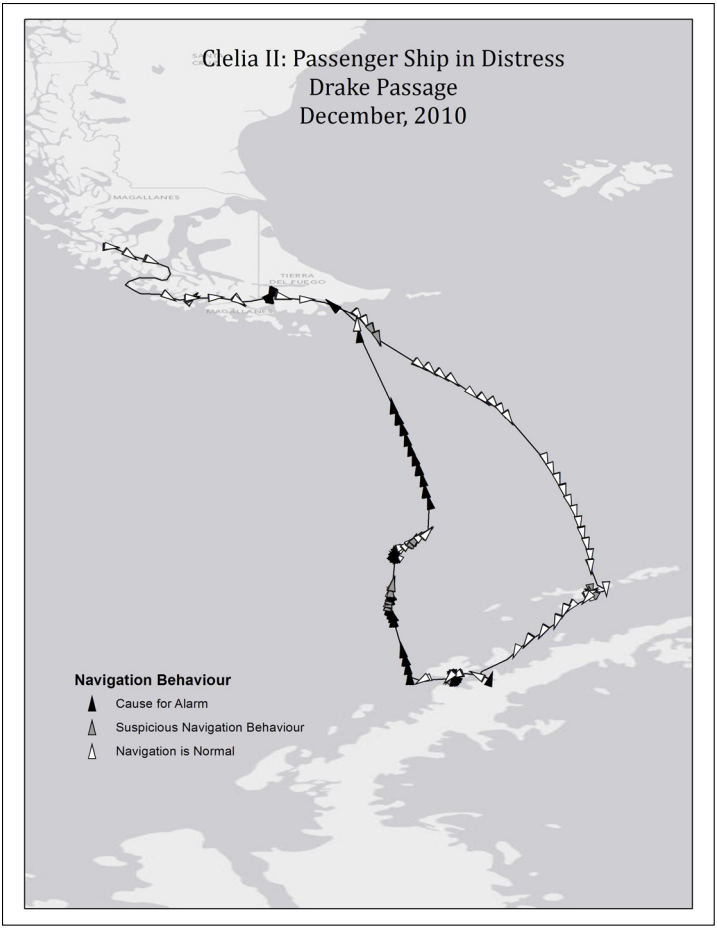



**Figure 5-2:** Navigation behavior for a ship in distress

# How S-AIS helps

exactAIS can help to save lives by making shipping a safer business in the following ways:

- Providing continuous coverage of the vessel, even in bad weather
- Allowing authorities to monitor risks in certain areas and intervene before disaster strikes

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

- Providing a complete set of vessel information to properly assess when a vessel is in danger, so authorities know the best way to assist
- Assisting in detecting vessels that are sailing at an unsafe speed
- Being able to combine its data with data about weather and sea conditions to know if a vessel is traveling too fast for the current conditions

# Security and Surveillance Case Study: Preventing Piracy

Modern-day piracy is a serious international problem, which you've no doubt heard about on the news in the past few years. Pirate attacks are drawing global attention, and pirates are increasingly prone to using violent force with automatic weapons and rocket-propelled grenades to seize vessels.

Unfortunately, crime can happen just as easily at sea as it does on land. Acts of piracy, armed sea robbery, environmental degradation, illegal fishing, and the trafficking of drugs, humans, and small arms are a few examples of what authorities are up against. These illegal activities are happening in both national and international maritime waters, and are a threat to governments and businesses alike.

The good news is that in the continuing fight against illegal activity at sea, more attention is being paid to finding solutions for identifying suspicious vessels.

## exactEarth against piracy

exactEarth is currently supplying data to the North Atlantic Treaty Organization (NATO) Shipping Centre in conjunction with Operation Ocean Shield, a counter-piracy initiative headed up by NATO. exactAIS data plays a key role in anti-piracy operations to create a better understanding of piracy operations and improve decision making and the effectiveness of joint operations.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

## The high cost of piracy

With more than 12 percent of the total volume of oil transported by sea flowing through the pirated area of the Gulf of Aden, many ships are avoiding the area altogether, which leads to longer voyages, lost earnings, and higher fuel costs.

## How S-AIS helps

With the exactAIS technology, preventing piracy is becoming easier:

- The data provides the ability to detect changes in a vessel's velocity, as well as disparities between course over ground and the ship's heading — all of which are signs that can indicate that a vessel is drifting or pirated.
- Operators are able to observe changes in velocity to alter course when required.
- Satellite data can identify maritime traffic patterns in highly pirated waters. These patterns can be analyzed to create safer shipping routes, so ships can avoid danger altogether. Figure 5-3 shows ships avoiding piracy areas.
- The data provides historical tracking that allows for deeper analysis into a ship's behavior, so authorities can know when a vessel may be at risk.
- Data can be used to form convoys and to guide vessels through a protected route, reducing the risk of possible pirate threats.
- exactAIS data can help authorities enforce anti-piracy rules in efforts to deter future attacks.
- The wide-area coverage provided by exactAIS gives enough information to thoroughly analyze and identify high-risk targets.
- exactAIS data can be used to help detect pirated ships earlier, so naval forces can respond more quickly.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

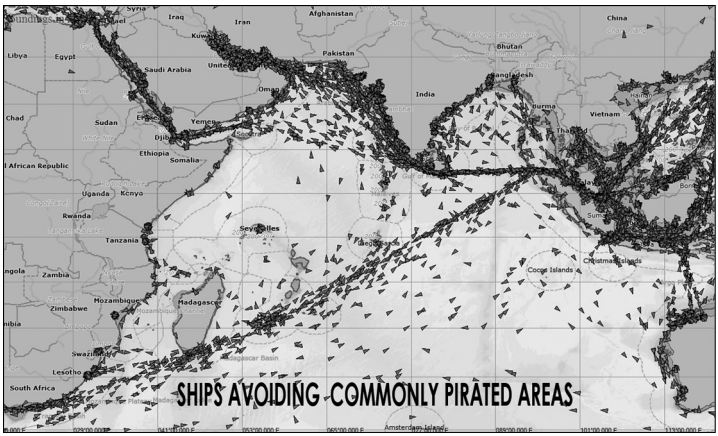



**Figure 5-3:** Ships avoiding commonly pirated areas

# Environmental Protection Case Study: Guarding Sensitive Areas

Oceans and coasts host some of the most productive ecosystems on earth, providing food and livelihoods to millions of dependent local communities, sustaining local and national economies, and supporting cultural services to human communities. However, the past decades have proved that marine ecosystems and resources are limited, vulnerable, and becoming increasingly degraded. Evidence is piling up to show that the world's oceans are in trouble because of pollution, and the world's fish populations are severely declining. Thousands of protected or environmentally sensitive sea areas have been created to try to fight these problems and protect the oceans.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

## Keep out of these areas

A *particularly sensitive sea area* (PSSA) is vulnerable to being damaged by shipping activities, and it needs special protection because it's important for ecological, socioeconomic, or scientific reasons.

A *marine protected area* (MPA) is any area that is protected by law because it has important flora or fauna, or historical or cultural features. The Great Barrier Reef is an example of an MPA.

*Areas to be avoided* typically include wind farms or oil and gas fields. They're areas within defined limits where navigation is especially hazardous for ships. No vessel traffic is permitted in these areas.

## How S-AIS helps

exactAIS can help to protect ocean environments in the following ways:

- Allowing authorities to monitor remote coastal regions and areas farther offshore that coastal AIS can't monitor
- Monitoring any vessels entering into protected zones to help authorities prosecute violators
- Providing historical data to analyze shipping patterns and trends to see if any changes are required to ensure vessels avoid the protected zones in the future

In Figure 5-4, you can see an overview of the Great Barrier Reef in Australia, and how exactAIS technology helps to monitor the vessels entering the region.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

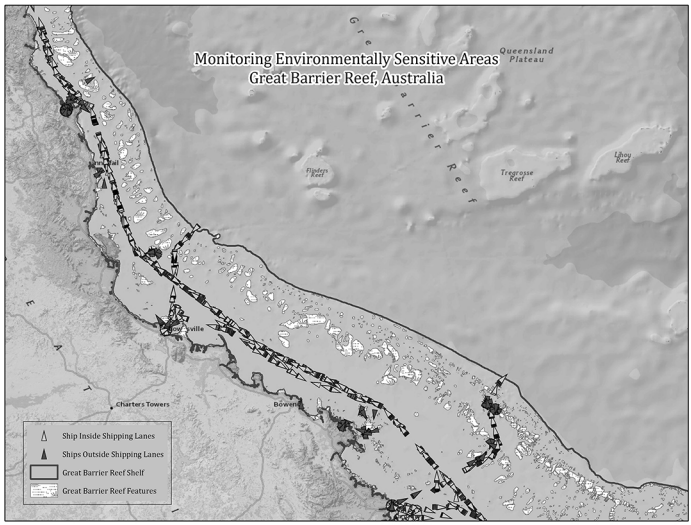
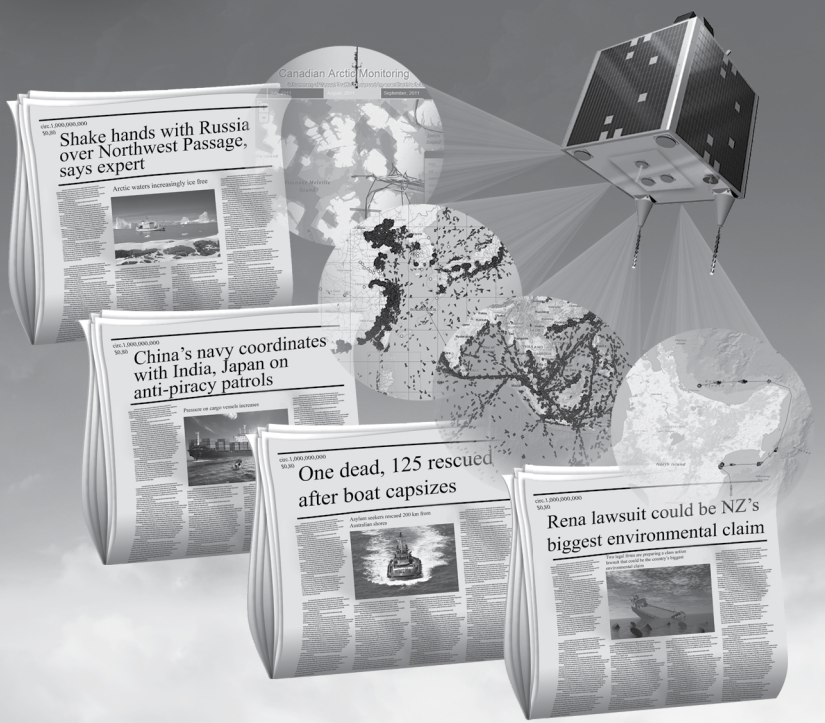



**Figure 5-4:** Monitoring environmentally sensitive areas

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

# We see a lot more than just ships


Canadian Arctic Monitoring
Shake hands with Russia over Northwest Passage, says expert
China's navy coordinates with India, Japan on anti-piracy patrols
One dead, 125 rescued after boat capsizes
Rena lawsuit could be NZ's biggest environmental claim

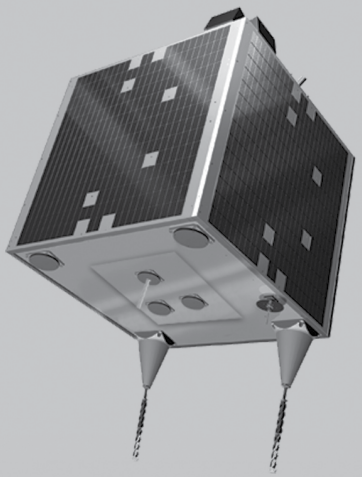
Data services for geointelligence
Providing the complete maritime picture

www.exactearth.com
info@exactearth.com

exactEarth®
Maritime Geodata Excellence


These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

# Completing the maritime picture



Take advantage of:

- The world's most advanced AIS satellite constellation
- Patented digital signal processing technology

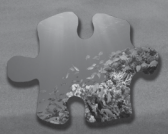
Providing:

- Unprecedented detail on ship movements
- The fastest and most complete ship detection available on the market today

Protecting Countries

Saving Lives

Enhancing Trade



Safeguarding Oceans

**www.exactearth.com**
**info@exactearth.com**

exactEarth®
Maritime Geodata Excellence


These materials are the copyright of John Wiley & Sons, Inc. and any dissemination, distribution, or unauthorized use is strictly prohibited.

## Dive right into tracking global maritime traffic with Satellite AIS technology

Thanks to recent advances in Satellite-based AIS technology, everything from tracking a single vessel to monitoring shipping across remote ocean regions has never been easier.

- ***Learn all about AIS* — find out about different types of AIS devices and their safety features**
- ***Explore expert tracking technology* — get straightforward explanations on how to track ships accurately and efficiently from space**
- ***Get to know the versatility of Satellite AIS* — see how you can keep track of vessels, improve search and rescue, enhance safety, and help preserve the environment**

**Open the book and find:**

- **How to build a complete picture of activities at sea**
- **Ways to analyze the impact of shipping on the ocean environment**
- **Tips on how to track pirates, polluters, perilous ships, and much more**
- **The many different applications of Satellite AIS technology**
- **The benefits of using exactAIS technology for tracking maritime traffic**

***Making Everything Easier!™***

**Go to Dummies.com®**
**for videos, step-by-step examples, how-to articles, or to shop!**

**Heather Ball** enjoys writing about almost any topic — from women artists to home repairs to health care — and has been doing so for over ten years. She has edited and written dozens of books, including several *For Dummies* titles.

WILEY

ISBN: 978-1-118-48494-4
Not for resale